COMBUSTION OF CARBONACEOUS RESIDUES ON SPENT OIL SANDS IN A TRANSPORT REACTOR

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ABSTRACT

A laboratory scale dense-phase transport reactor was designed, fabricated and constructed to study the combustion of carbonaceous residues on spent oil sands produced during the fluidized bed pyrolysis of oil sands. A wide particle-size distribution group B coked sand, $\bar{d}_p$= 130 μm, was used for the hydrodynamic and combustion studies.

The average minimum fluidization velocity, U_{mf}, determined during a series of fluidization and defluidization experiments, was 1.7 cm/s. The transition velocities were determined in flow regime transition studies: (a) the plug slugging transition velocity, U_{ms}, was 22 cm/s; (b) the turbulent fluidization transition velocity, U_c, was 50 cm/s; and (c) the refluxing pneumatic transport transition velocity, U_k, was 75 cm/s. Particle residence time distribution experiments indicated the average particle residence time in the reactor was approximately six minutes in the turbulent fluidization regime.

The effects of process variables on the combustion of the coked sand were investigated. Coked sand combustion experiments at different superficial gas velocities indicated that there was an preferred superficial gas velocity, approximately 60 cm/s, at which the highest coke conversion was achieved.

The results also indicated that CO production rate increased whereas CO_2 production rate decreased with increasing superficial gas velocity. Coke conversion increased with increasing combustion temperature but leveled off above 946 K.

The coke conversion increased with decreasing solids feeding rate at a fixed temperature. Coked sand combustion with oxygen enriched air as the fluidizing gas indicated that using oxygen enriched combustion gas increased the coke conversion.

Preliminary studies were conducted to evaluate the effect of gaseous swirl flow on coked sand combustion. Coke conversion increased with swirl flow at a fixed temperature and solid feed rate relative to fully developed plug flow through the reactor. It is expected that coked sand combustion could approach completion with a combination of induced swirl flow, higher combustion temperatures and oxygen enriched fluidizing gas.

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